VARIATION OF FREE PROLINE ACCUMULATION AND PHENOLOGY OF RICE UNDER ALTERNATIVE IRRIGATION AND SUSPENSION OF IRRIGATION SCHEMES

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INTRODUCTION

Accumulation of free proline in plant cells in response to onset of stress is one of the mechanisms (Vendruscolo *et al.*,2007; Cattivelli *et al.*,2008) adapted to survive under water stressed conditions (Bates *et al.* 1973). Scientists have studied physiological and phenological modifications of rice under water limited environments giving higher yields, under field level (Nguyen *et al.* 2009 & Ginigaddara and Ranamukhaarachchi 2009). However, testing such adjustments and modifications in the field level under actual water stress is hampered by shallow ground water table, as upward capillary movement of water during evapo-transpiration streams nullifies the actual water stress. Greenhouse pot experiments are very much helpful in this regard to study the morphological and physiological responses of rice plant under actual water stress (Yoichiro *et al.* 2007) and this study was conducted to determine the physiological adjustments and phenological variations of the rice plant when exposed to absolute water stress conditions.

MATERIALS AND METHODS

Green house pot experiment was conducted in Agricultural Systems research farm of the Asian Institute of Technology, Bangkok from March to August, 2008. Four different water management schedules, viz. conventional water management (CWM), and three alternate irrigation and suspension of irrigation (AISI) treatments (2-week irrigation followed by 2-week suspension of irrigation; 2I-2S), 1-week irrigation followed by 3-week suspension of irrigation; 1I-3S) and 1-week irrigation followed by 4-week suspension of irrigation; 1I-4S) were used. The rice variety Suphan Buri 1, which is a non- photosensitive with a maturity period of 120 days and recommended to Central plains of Thailand, was used. In CWM, water level of 4cm was maintained in pots during flooding. Except in CWM, irrigation followed by suspension of irrigation was repeated

until flowering; thereafter the field was inundated to a depth of 5 cm until dough stage, and then pots were drained out 2 weeks prior to maturity to facilitate grain drying. The experiment was arranged in a CRD with 6 replicates each. Variations in plant phenology and free proline accumulation were measured (Bates *et al.* 1973) during the experimental period.

RESULTS AND DISCUSSION

There was a significant effect of water management treatments for the time taken to reach 50% flowering and physiological maturity of rice (Table 1).

Table 1: Important phenological developments and growth durations under different water management practices

Treatment	Start of flowering, DAP	50% flowering, DAP	Physiological maturity Maturity, DAP
CWM	82.8 ± 5.0 c	93.2 ± 3.6 d	123.0 ± 0.0 d
2I-2S	92.0 ± 2.3 b	102.0 ± 2.5 c	130.0 ± 0.0 c
1I-3S	95.5 ± 0.5 b	105.2 ± 0.4 b	137.8 ± 4.3 b
1I-4S	110.3 ± 2.2 a	119.7 ± 2.8 a	150.0 ± 2.4 a
LSD (p=0.05)	3.6	3.2	3.0
Analysis of variance			
Source of Variation	DF	Mean squares	
Treatment	3	784.55***	728.33***	803.70***
Error	20	8.88	6.85	6.14
CV%		3.13	2.49	1.83

DAP- Days after transplanting

The rice in CWM flowered first (82.8 days) and 1I-4S took the longest time of 110.3 days. This shows the delay in reaching phenological stages with increasing the length of the period of suspension of irrigation (Xiaoguang *et al.*, 2005). Such variation in growth plasticity can occur as a result of water stress in rice, and finally can interfere with cropping patterns. The time taken from

establishment to flowering of rice is important as the accumulation of assimilates during vegetative period contributes to the weight of rice grains and hence the yield (Ntanos and Koutroubas 2002).

Free proline accumulation in leaves

There was a clear variation of tissue proline content between CWM and AISI treatments and also within AISI treatments (Figure 1). There were increases in the proline content in all AISI treatments during suspension of irrigation (P=0.05), and the level of proline even increased with increasing the length of the period of suspension of irrigation. Upon increased soil moisture with resumed flooding, proline content in tissues decreased. Mostajeran and Rahimi-Eichi (2009) also observed higher amount of plant proline content in non-submerged rice and a positive correlation between free proline accumulation and drought tolerance of different rice varieties.

The production of free proline in the rice plant varies with the age (Mostajeran and Rahimi-Eichi 2009), and is exemplified with the proline levels after resuming irrigation in the second cycle. Proline acts as an osmolyte produced under water stress and plays a significant role in drought adaptation of plants. Phenological development in AISI treatments remained severely unaffected. However, the delayed phenological developments of the 1I-4S water management treatments were due to prolonged water stress resulted from longer period of suspension of irrigation.

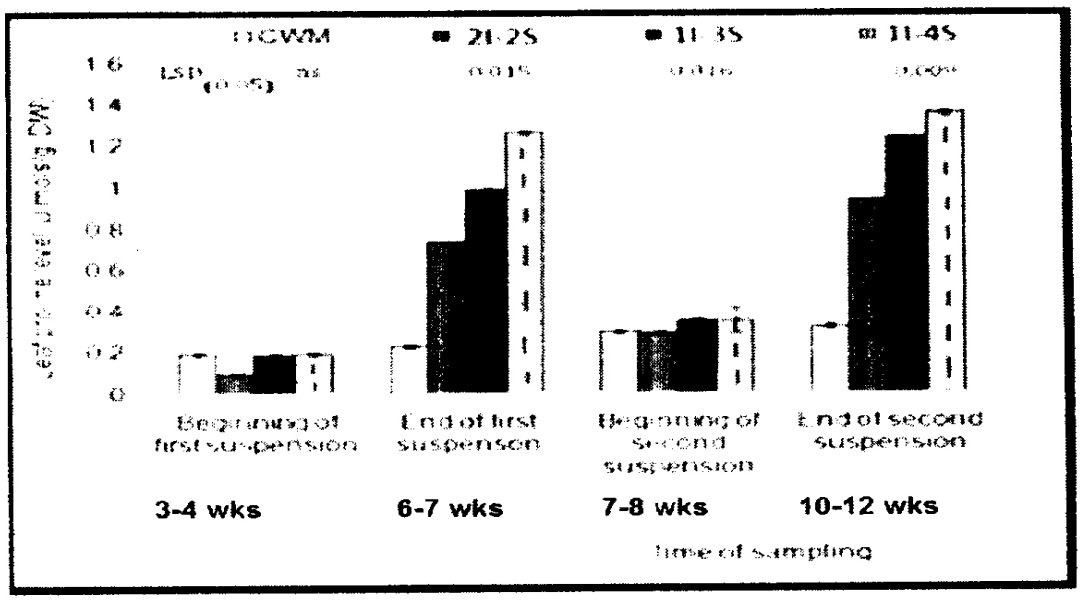

Figure 1- Variation of the free proline content in leaves of rice prior to commencement of and resumption of suspension of irrigation